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Harlequin Duck
Conservation Management Plan

2010 – 2015

Alberta Conservation Management Plan No. 4

Government of Alberta

Harlequin Duck

Conservation Management Plan

2010-2015

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September 2010

Government of Alberta

Sustainable Resource Development

Publication No.: I/473
ISBN: 978-0-7785-9992-0 (Printed Edition)
ISBN: 978-0-7785-9996-8 (On-line Edition)
ISSN: 1922-9976 (Printed Edition)
ISSN: 1922-9984 (On-line Edition)

Cover photos: Drajs Vujnovic

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OR

Visit the Species at Risk Program web site at:

http://srd.alberta.ca/BioDiversityStewardship/SpeciesAtRisk/

This publication may be cited as:

Alberta Sustainable Resource Development. 2010. Harlequin Duck Conservation Management Plan 2010-2015. Alberta Sustainable Resource Development. Species at Risk Conservation Management Plan No.4. Edmonton, AB. 17 pp.

PREFACE

Albertans are fortunate to share their province with a diversity of wild species. A small number of these species are classified as Species of Special Concern because they have characteristics that make them particularly sensitive to human activities or natural events. Special conservation measures are necessary to ensure that these species do not become Endangered or Threatened.

Conservation management plans are developed for Species of Special Concern to provide guidance for land and resource management decisions that affect the species and their habitat. These plans are intended to be a resource tool for Sustainable Resource Development - Fish and Wildlife Division (SRD-FWD) and for provincial and regional land and resource management staff.

Conservation management plans provide background information including species biology, threats to species and habitat, and inventory/monitoring history. Plans also provide a goal, objectives, and actions (management recommendations). Management recommendations are typically categorised into inventory and monitoring needs; habitat management and conservation; education and communication; and additional management considerations as required.

Conservation management plans are generally prepared by an SRD-FWD biologist who has been designated as the provincial species lead. Writers from outside SRD-FWD are occasionally sought to prepare plans for species for which there is little in-house expertise. In order to ensure accuracy and utility, each plan is reviewed by a species expert and a designated provincial representative from SRD Forestry Division and/or Lands Division. In some cases there may be additional reviewers from staff, industry, and other agencies.

Conservation management plans are internal guidance documents. They are implemented under the guidance of the species lead and are "living" documents that can be revised at any time as required. Conservation management plans are more succinct than the recovery plans that are prepared for Endangered and Threatened species and do not involve participation of a multi-stakeholder team.

Conservation management plans are approved by the Director of Wildlife and/or Directory of Fisheries. Plans will be reviewed annually by the species lead and updated if necessary, and a more in-depth review will occur five years after a plan's approval.

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EXECUTIVE SUMMARY

The harlequin duck (*Histrionicus histrionicus*) is a sea duck that winters on the Pacific Northwest coast, and comes to Alberta to breed. It is found in the mountains and foothills, nesting along swiftly flowing clear mountain streams where there is suitable nesting cover.

The harlequin duck has been designated as a *Species of Special Concern* in Alberta, because it has narrow breeding habitat requirements, a relatively small population size, and is sensitive to disturbance during breeding. The primary threats to this species are habitat alteration and human disturbance.

This plan recommends various ways to conserve harlequin duck populations and habitat, including: design and implement monitoring protocols to track population trends and identify potential risks; set guidelines to protect habitat from various activities; address knowledge gaps relevant to conservation issues; and inform recreational users about harlequin ducks, their habitats, and threats.

ACKNOWLEDGEMENTS

A number of biologists graciously shared their expertise and/or reviewed early stages of the draft plan: Paul Gregoire (CWS), Anne Hubbs (SRD, Fish and Wildlife Division), Beth MacCallum (Bighorn Wildlife Technologies Ltd.), Dale Patton (Anatum Consulting), and Richard Quinlan (SRD- Fish and Wildlife Division). Special thanks to Cyndi Smith (Parks Canada) for providing input and conducting the final review. Thank you also to Dave Hugelschaffer (SRD, Lands Division) for reviewing the plan.

1.0 INTRODUCTION

The harlequin duck (*Histrionicus histrionicus*) has been designated as a *Species of Special Concern* in Alberta, because it has narrow breeding habitat requirements, a relatively small population size, and is sensitive to disturbance during breeding (ESCC 2000). Populations, based on surveys at wintering grounds, appear to have been declining since 1994 (Robertson and Goudie 1999, Smith et al. 2001, Rodway et al. 2003).

The Alberta Endangered Species Conservation Committee's Initial Conservation Action Statement (2000) for the harlequin duck recommends the following:

- Develop and implement a conservation and management strategy for the harlequin duck in Alberta.
- Conduct active conservation and management of harlequin duck habitat.

1.1 Breeding Biology, Distribution and Habitat Requirements

Harlequin ducks spend 8-10 months of the year in rocky coastal habitats of the Pacific Northwest (primarily the Strait of Georgia for ducks that breed in Alberta) and pairs migrate inland to breed (Smith and Smith 2003). In Alberta, they are found in suitable habitat in the mountains and foothills (Figure 1). They arrive in late April or early May (Cooke et. al. 2000). Males return to the coast in mid-June or early July (Cooke et. al. 2000), leaving females to raise broods, which typically hatch around mid-July (Hunt 1998, MacCallum and Burgera 1998, Smith 1999a and 1999b). Breeding hens and broods return to the wintering coastal areas in mid-August to mid-September (Cook et al. 2000, Regehr et al. 2001). Failed breeding hens may remain on the breeding grounds throughout July but most leave for the coast by early August (Hunt 1998).

Harlequin ducks generally nest within 5m of the water along swiftly flowing, clear mountain streams with suitable nesting cover on islands or stream banks (Bengston 1972, Cassirer et al. 1993, MacCallum and Bugera 1998, Smith 1998). Additional nesting habitat characteristics include low stream reach gradients and presence of rocky substrates (Cassirer et al. 1996). Nests are commonly located on small tributaries of main channels of streams and along major streams (i.e., main channel) at high elevations (Smith 2000b). Nest site selection may be associated with anti-predator strategies and serve to reduce exposure to human disturbance. Predation risk from mink and raptors, at least in some areas, may influence nest location within stretches of suitable stream habitat (Bengtson 1972, Heath et al. 2006). Pairs usually return to the same drainage each year, showing strong breeding site fidelity (sites are often within the female's natal watershed) (Smith 2000b, Smith et al. 2000).

Female harlequin duck breeding success has been reported to be low until five years of age (Reichel et al. 1997). Individuals may not breed every year, which results in low productivity, and most males do not form pair bonds until three years of age or older (Robertson et al.1998). It appears that a small proportion of females produce a high proportion of young (Robertson and Goudie 1999), although reasons for this are unclear. Harlequin ducks seem to have a high tendency to initiate egg-laying (e.g., only 2 of 17

(11.8%) radio-marked females failed to nest on the Bow River; Smith 2000b; see also Bond et al. 2008) and egg laying responds to environmental conditions. Invertebrate availability during the breeding period is critical for harlequin persistence and reproductive success (Wright et al. 2000). The hypothesis that harlequin ducks are food limited on the breeding grounds has been supported by findings in southwest Labrador (Rodway 1998), British Columbia (LeBourdais et al. 2009, Bond et al. 2007), and Iceland (Einarsonn et al. 2006).

Pairs of harlequin ducks display high fidelity to each other on breeding steams in Alberta and on wintering areas in British Columbia (Smith et al. 2000), and females have been reported to arrive with their broods at wintering areas (Regehr et al. 2001). It appears that winter aggregations are composed of harlequin ducks from a number of breeding stream complexes, each of which is demographically independent from other breeding streams (Cooke et al. 2000, Robertson et al. 2000, Esler et al. 2002, Iverson 2004). This means that for a particular subpopulation, breeding female numbers and recruitment are dependant on the survival and productivity occurring within the subpopulation itself because of limited or no immigration between breeding streams (Esler 2002, Heath et al. 2006). Demographic isolation may occur within harlequin duck populations at levels of tens to hundreds of kilometres (Iverson et al. 2004).

Research in Labrador demonstrated that source streams sustain local subpopulations and are differentiated by biophysical features from a matrix of satellite streams (Heath et al. 2006). Source streams are characterized by excess annual productivity and relatively high and stable pair density among years, regardless of changing environmental factors among years. Satellite streams, which are characterized by low productivity and relatively low and unstable pair density among years, are populated by pairs that were unsuccessful at securing a nesting site on source streams.

1.1.1 Abundance and Distribution

The general status of Alberta wild species 2005 (ASRD 2007) provides an estimate of between 2000-4000 harlequin ducks. The upper estimate was based on potentially finding new local breeding populations in places like the Canadian Shield in northeastern Alberta (harlequins breed in the Northwest Territories just north of the Alberta border) (MacCallum 2001). It is instructive to have a provincial population estimate; however, effective on-the-ground conservation will require ongoing monitoring and management at a regional scale (e.g., Cooke et al. 2000, Esler 2002, Iverson et al. 2004). Because measures of demographic process for individual streams may not reflect regional characteristics (Heath et al. 2006), it will be important to determine which breeding streams constitute a 'region'.

Figure 1. Harlequin duck range in Alberta

1.2 Threats to Populations

The primary threats to harlequin duck populations are human disturbance and habitat alteration to both streams and the relatively narrow adjacent riparian habitat (Robertson and Goudie 1999). Approximately 70% of harlequin range in Alberta is in some kind of protected area; however, they are still vulnerable to disturbance from recreational activities (Hunt 1998). Because harlequins occur at low numbers, small increases in cumulative impacts could easily diminish nesting and recruitment rates. The long-lived nature of the species and its apparent stability on source and/or larger population streams may obscure overall population declines until severe changes occur.

Increased adult mortality can have a significant impact on harlequin duck populations (Goudie et al. 1994, Esler 2002) because of the relatively long reproductive life span and low probability of female immigration. In Alberta estimates for reproductive life span range from 2.9 years for the McLeod River (MacCallum and Godsalve 2004), to 4.1 years for the Bow River (Smith 2000a, 2000b). Breeding season survival rates for females on the Bow, Kananaskis, Elbow and McLeod rivers (0.75) were lower than for those in the Coast Mountains of B.C. (0.88) and Cascade Mountains of Oregon (0.89) (Bond et al. 2009). Survival was lower for females in all areas during incubation than during nest initiation or brood rearing. Overall, female survival rates were lower during the summer breeding period than during winter (Cooke et al. 2000), so management actions designed to reduce mortality during breeding could have population-level benefits (Bond et al. 2009).

1.2.1 Habitat Alteration on the Breeding Grounds

A number of types of industrial activity can negatively affect harlequin duck habitat (Cassirer et al. 1996, Genter 1993), and birds may not be able to breed in alternate sites because of their narrow habitat preferences. In addition to removing habitat or rendering it unsuitable for nesting, habitat alteration may result in changes to availability of and timely access to resources, as well as increasing vulnerability to predation or reducing competitive capabilities (Garshelis 2000). The relatively remote location of some harlequin duck habitat may afford protection from some types of human-caused habitat alteration.

Habitat suitability for harlequin ducks could be reduced by activities that negatively affect the following:

- Hydrology. Hydrology of an area can be altered when large-scale changes are made to the landscape, such as mining, road-building, forestry, etc. This can result in higher stream flow events during spring, which has potential to flood nests and reduce or eliminate invertebrate prey (see Cassirer et al. 1996, Hunt 1998, Hill and Wright 2000). At the other extreme of flow alteration, low water levels can occur later in the summer (Hill and Wright 2000), which may force broods into open areas where they are more vulnerable to predation.
- Water quality. Occurrences such as deposition of mine tailings or increases in sedimentation can negatively alter the invertebrate community and/or the ability of harlequin ducks to forage on invertebrate prey (Hunt 1998, Wright et al. 2000, Bond 2005)
- Streamside vegetation. Removal of streamside vegetation can reduce security cover for nests and broods, reducing suitability for nesting and increasing vulnerability to predation (Inglis et al. 1989, Wright et al. 2000)

1.2.2 Habitat Disturbance/Human Activity

Maintenance of suitable habitat where harlequin ducks can flourish is fundamental to harlequin duck conservation; however, current levels of human activity, including both recreational and industrial activity, pose a threat to harlequin ducks. Although some harlequin ducks might tolerate moderate levels of disturbance, some will abandon preferred nesting sites, particularly when disturbances become chronic (Cassirer and Groves 1991). Reduced productivity and increased vulnerability to predation result when ducks are forced into suboptimal habitat (e.g., Heath et al. 2006). Moreover, increases in human activity are often associated with increases in predators (e.g., Restani et al. 2001, Webb et al. 2004, Kristan and Boarman 2007). Ecological traps/sinks (i.e., low quality habitat that animals may use over other available habitats of higher quality) may result where habitats have been modified by human activities, affecting stream complex productivity (Battin 2004; Heath et al. 2006). Determining changes in subpopulation demographics requires an understanding of source-sink relationships (Esler et al.2002, Jonzen et al. 2005).

Recreation

The remoteness of some harlequin duck streams may reduce the risk from recreational users; however, several breeding sites are in areas of high human activity, particularly in southwest Alberta. Activities such as fishing, random camping, hiking on trails immediately adjacent to streams, ATV use, kayaking, rafting and backcountry endurance races are known to occur in harlequin duck foraging, nesting and brood-rearing habitat. These activities have potential to affect behaviour of nesting ducks (e.g., nest abandonment, deter birds from preferred habitat, more time spent in vigilance than foraging), and may result in increased energy expenditure. Jasper National Park and Glacier National Park, MT, have each closed a river to boating to reduce disturbance to foraging and brood-rearing harlequin ducks (C. Smith, pers. com.).Recreational activities, in particular random camping, are especially prevalent in southwest Alberta, where two suspected cases of nest abandonment have been attributed to congregations of campers (D. Paton, pers. comm.).

Streamside construction or trail enhancement may also be detrimental. For example, construction of a new scenic viewing platform at LeHardy Rapids in Yellowstone National Park, WY, displaced harlequin ducks from a preferred foraging area (Hunt & Clarkson 1993).

Linear Disturbance

Activity from construction and use of roads and other linear disturbances that parallel streams have potential to diminish habitat suitability (Cassirer et al. 1996, Hill and Wright 2000). In cases where highways cross harlequin duck streams, low bridges may cause ducks to fly over the bridge instead of under, increasing risk of predation and collision with vehicles (Smith 2000b). Also, unless the bridge span includes shoreline, ducklings may not be able to swim upstream against the current (Smith 2000b).

1.2.3 Other Threats

Hunting

Harlequin ducks are game birds; however, waterfowl hunting generally does not occur within their range in Alberta. The timing of open hunting seasons does not coincide with the period when males are in Alberta, and females have typically left Alberta, or will leave Alberta, within two weeks of any waterfowl season opening in Alberta. Hunting outside provincial boundaries could contribute to a decline if populations are not managed appropriately (at least eight harlequins that were recorded in Alberta were later shot in the USA; C. Smith, pers. comm.), although this does not appear to be a problem at present (based on high winter survival in the Strait of Georgia; Cooke 2000).

Fish Habitat Enhancement

Altering fish habitat to improve fishing opportunities may affect habitat suitability for harlequins and, more importantly, will lead to increased human disturbance. However, fisheries habitat enhancements typically occur in easily accessible front country so this is considered a minimal threat. Fish stocking can also pose a risk to harlequin ducks by potentially altering behaviour and composition of invertebrate communities (LeBourdais 2006).

Wintering Grounds

Harlequin ducks are susceptible to threats on their wintering grounds that reduce reproductive fitness or cause mortality, such as habitat alteration, disease, oil spills, and severe weather events (Esler et al. 2002). Survival during winter (Cooke et.al. 2000), including the moult period (Iverson and Esler 2006), indicate that harlequin ducks, particularly females, are at lower mortality risk on the wintering grounds.

Climate Change

Changes to annual temperature regimes could alter stream flow and abundance and hatching times of aquatic invertebrates. Another possible change would result if climate change leads to annual precipitation coming more often as storm events, such as heavy rains, which could impact nest success or cause brood mortality (observed on Moraine Creek; C. Smith, pers. comm.).

1.3 Provincial Monitoring History

Since 1992, inventory and monitoring has occurred in the Bow, Athabasca, McLeod, Oldman, Kananaskis, and Smoky River drainages. Refer to Table 1 for a list of streams, survey years, and investigating agencies.

Table 1. Harlequin duck inventory and monitoring history in Alberta.

Drainage	Years	Type	Method*	Report
Kakwa River Torrens River Beaverdam River	1998, 2000	Abundance, distribution	Aerial survey	Gregoire 1999; James and Ripley 1999; St.Laurent 2007
McLeod River	1996-2006	Abundance, distribution, productivity, vital rates	C-M-R; Telemetry Aerial Survey	Gregoire et al. 1999; Kneteman and Hubbs 2000; MacCallum and Godsalve 2004; MacCallum 2007
Cardinal River	1996 1998	Abundance, distribution	Instream foot survey Aerial Survey	Gregoire et al. 1999
Gregg River	1998	Abundance, distribution, productivity	Instream foot survey Aerial Survey	MacCallum 1999; Gregoire et al. 1999
Solomon Creek	1997	Abundance, distribution	Instream foot survey	Hobson 1997
Willmore	1998- 2006	Abundance,	Aerial survey	Kneteman and

Wilderness		distribution, productivity		Hubbs 2000; Kneteman and Vujnovic 2007
Maligne River	1992 - 1995	Breeding, distribution, productivity, recreation	C-M; Observation	Hunt 1998
Blackstone River N. Saskatchewan R. Cline River Ram River Clearwater River Red Deer River	1998	Abundance, distribution	Aerial survey	Gregoire et al. 1999
Sheep River	1999-2003	Distribution, abundance	One hiking survey of 20 km of river annually	W.Smith, Running Wolf Research, for Alberta Environment, Canmore
Kananaskis Country (Elbow, Sheep and Highwood rivers)	1995	Abundance, distribution	Roadside, hiking and canoe surveys	Benz 1995
Kananaskis Country (primarily Kananaskis, Elbow and Sheep Rivers)	1996-2000	Abundance, distribution, productivity, vital rates	C-M-R; telemetry	Smith 2000
Bow River - Banff	1992-1994	Abundance, distribution	Canoe surveys	Smith & Clarkson 1995
Bow River - Banff	1995-2009	Abundance, distribution, productivity, vital rates	C-M-R; Telemetry; Observation	Smith 2000a; Smith 2000b; Campbell 2005; C.Smith (unpubl. data)
Oldman River Livingston River, Racehorse Creek	1998- 2002 2004 – 2010 (comprehensive survey in 2000)	Trend in Abundance, distribution, productivity	Annual trend surveys hiking six representative reaches	Paton 2000, Quinlan, unpubl. data
Carbondale River, Lynx Creek	1997-1998 2000-2002 2004-2010	Trend in Abundance, distribution, productivity	Annual trend surveys hiking six representative reaches	Quinlan, unpubl. data

*C-M = capture and mark; C-M-R = capture, mark, and recapture

2.0 GOALS AND OBJECTIVES

2.1 Goal

Maintain current distribution and occupation of breeding streams of harlequin ducks in Alberta, as per the previous (beginning in the mid-1990s) and most current survey data available (refer to Table 1).

2.2 Objectives

1. Inventory and monitoring: Design and implement monitoring protocols that will allow tracking of population trends and identify potential risks to both populations and habitat.

2. Habitat Management: Set guidelines to protect harlequin duck habitat from both industrial, recreational and fisheries enhancement activities.

3. Research: Address knowledge gaps relevant to harlequin duck conservation and management.

4. Education and communication: Inform recreational users about the description and sensitivity of harlequin duck breeding habitat, and associated timing concerns.

3.0 MANAGEMENT ACTIONS

3.1 Inventory and Monitoring

Because harlequins are long-lived, there could be a time lag before population declines are detected. Proper monitoring techniques will minimize such a time lag. To ensure that any declines are detected early, the following steps are recommended (the first three points are the highest priority):

- Identify local breeding populations (and if possible break down into source and satellite streams) and evaluate level of risk (i.e., threats to population and habitat) to determine priority streams for monitoring. Identify high priority drainages, on a regional basis, using the following criteria (level of risk may also be considered):
  - local breeding population that is consistently present and of a reasonable size to sustain each particular breeding subpopulation
  - reliable monitoring history
  - accessibility
- Conduct brood surveys on priority drainages every year if possible. Conduct spring pair surveys every 3-5 years (coinciding with once per breeding generation of approximately 4-5 years; Smith, pers.comm.). Different survey techniques may be used in different regions; however, consistency within regions should be maintained. Other monitoring protocols have recommended annual or biannual pair and brood monitoring of high priority drainages, and rotational sampling on all other breeding streams (Skalski 1995 in Cassirer et al. 1996); however, it is

- At a maximum interval of every five years, assess monitoring data to determine if any subpopulations appear to be declining. If a decline is detected, management activities should be evaluated and changed accordingly. It may be necessary to modify the monitoring protocol and initiate research that will address specific questions. It is essential that management actions are initiated concurrently with research to avoid continued declines.
- If ongoing or new threats arise in areas where presence of harlequin ducks is unknown but possible, or where there are historical but no recent records, then surveys should be conducted.
- Determine when banding is required as a research and monitoring tool (e.g., when individual animal data will benefit the species) and what is the best time to capture and band ducks; consider a periodic banding program where appropriate (e.g., Smith 2001, Banff: Campbell 2005).
- Determine length of preferred streams to combine with population counts to calculate density and year-to-year differences in the length of the linear habitat provided by streams.
- Store monitoring data in the provincial Fisheries and Wildlife Management Information System (FWMIS) and distribute to resource managers and other relevant parties as required.

3.2 Habitat Management

Activities within harlequin duck habitat should be designed and carried out in a manner that is compatible with conservation of this species. Generally, protective area notations (PNTs), which identify a static point or small area, are not suitable for this species because harlequins use long stretches of streams, and nesting locations may vary from year to year. However, in cases where nests are regularly located within small stretches, PNTs may be appropriate.

Existing guidelines and policy objectives (e.g., Sustainable Resource Development 2005a,b, Alberta Environment 2008, Department of Fisheries and Oceans 2008), will help, to some extent, to guide protection of harlequin duck breeding habitat from most industrial activities, with the exception of large-scale activities that could potentially alter hydrology. In practice, maintenance of harlequin duck habitat is accomplished by keeping industrial activity out of watercourses and maintaining riparian buffers. Pipeline crossings should be installed by boring or drilling and vehicle access crossings by temporary bridges. Instream activity associated with surface mining should be avoided.

Current riparian policy objectives (Sustainable Resource Development 2005b) address a wide range of riparian types, and existing guidelines address many of the activities that have the potential to affect harlequin duck habitat. However, most existing guidelines are not specific enough for harlequin duck habitat protection; those that are most relevant for harlequin duck habitat protection (e.g., Alberta Environment 2008, Department of Fisheries and Oceans 2008) are designed to protect fish habitat during spawning. Timing

constraints associated with fish habitat guidelines may be insufficient to protect ducks throughout their nesting and brood-rearing period. Additional guidelines are required that are specific to harlequin duck habitat in both scope and timing (see below), and will not conflict with existing guidelines.

Additional recommendations for industrial (3.2.1) and recreational (3.2.2) activities follow.

3.2.1 Recommendations for Industrial Activity

The following recommendations, largely adapted from Cassirer et al. (1996), are for known harlequin duck breeding areas:

- Avoid instream activity during the harlequin duck breeding period (May through September). Activities outside this period should be conducted in a way that does not alter habitat (e.g. avoid stream crossings, or when unavoidable, use bridges instead of culverts).
- When developing new roads and other structures avoid the areas within 100-300 m of a stream (roads should not be visible from stream and setback distance should be determined site-specifically based upon nature of habitat and activity).
- For existing roads which pass within 100 m of breeding areas and stream reaches that are regularly used by harlequin ducks, opportunities for relocation and reclamation should be explored.
- Maintain riparian vegetation, including snags and wood debris, within 100 m of stream reaches that are regularly used by harlequin ducks.
- On regulated streams and rivers that have harlequin ducks, maintain streamflow regimes that emulate natural flows.
- Do not locate solid and sanitary waste facilities within riparian areas.
- Develop site-specific management and mitigation plans where appropriate.

3.2.2 Recommendations for Recreational Activity

The following recommendations, largely adapted from Cassirer et al. (1996), are for known harlequin duck breeding areas (these may not be applicable in all regions):

- When developing new recreational trails, locate them a minimum of 100 m away from streams and avoid increasing stream access.
- When developing or expanding campgrounds, locate them a minimum of 200 m away from streams and rivers that have harlequin ducks; explore opportunities to relocate existing sites.
- Discontinue issuance of commercial permits for recreational activities and instructional schools within 500 m of breeding areas (e.g., ATV instructional trails, whitewater boating).
- Develop guidelines for use by boaters in harlequin duck habitat (Banff National Park has created guidelines for this purpose; Parks Canada, 1999).
- Review areas where motorized boating activity may be in conflict with harlequin duck breeding season (e.g. commercial boating and fishing permits) and explore measures to remove or mitigate this threat..
- Where harlequin duck populations are declining explore access control measures (e.g., seasonal road closures, stream closures).

- Where harlequin duck populations are being disturbed or nest damage is occurring due to disturbance from anglers and/or ATVs, consider delaying fishing season to open later (July).

3.3 Research

- Identify and address knowledge gaps, such as:
    - Determine where young, non-breeding and first-time breeding birds that have returned to the breeding streams spend their summers
    - Determine the relevance of secondary streams (i.e., streams with lower harlequin duck presence).
    - Determine habitat characteristics (at multiple scales) that explain spatial distribution along a stream length including hydrology, vegetation, gradient, etc.

- Determine vital rate metrics from declining and stable populations, including:
    - Apparent female survival (some of this work is complete), breeding propensity, and true female survival (during nesting and brood rearing)
    - Cause of mortality (unless low apparent survival is due to dispersal)
    - Dispersal rates, specifically permanent emigration
    - Philopatric and recruitment differences between declining and stable populations
    - Nest success and egg survival (predation rates) differences

3.4 Education and Communication

Education should be aimed at backcountry users, especially anglers and random campers. The following information should be communicated: harlequin breeding habitat description, timing of breeding, and why harlequins are sensitive to human disturbance. However, it is challenging to communicate this information to backcountry users and even more difficult to know whether it will result in changes in behaviour. Before and after surveys of backcountry users should be considered to track the effectiveness of outreach efforts.

Information could be communicated in the following ways:

- Provide notices at visitor centres in provincial and national parks.
- Include a message with fish licences in relevant locations.
- Post signs along trails and OHV routes that indicate when people enter harlequin duck habitat, and request no camping within 200 m of streams from July to mid-September.
- Provide information to recreational boating clubs, magazines, etc.
- Consider signage at traditional put-in areas (e.g., Elbow River).

4.0 SUMMARY

Protection of habitat from alteration and protection of harlequin ducks from human disturbance are key to harlequin duck conservation in Alberta. In addition, continued monitoring of high priority breeding populations and evaluation of population trends at least every five years are necessary to recognize declines and implement management actions as required.

This management plan will be reviewed in five years, and may be updated prior to that time if new relevant information becomes available. The review will be lead by FWD, in consultation with researchers, participating agencies, and industry.

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